

(12) UK Patent Application (19) GB (11) 2 266 180 (13) A

(43) Date of A publication 20.10.1993

(21) Application No 9207895.5

(22) Date of filing 10.04.1992

(71) Applicant
EEV Limited

(Incorporated in the United Kingdom)

106 Waterhouse Lane, Chelmsford, Essex, CM1 2QU,
United Kingdom

(72) Inventors
Michael Barry Clive Brady
Julian Richard Robinson

(74) Agent and/or Address for Service
The General Electric Company plc
GEC Patent Department, Waterhouse Lane,
Chelmsford, Essex, CM1 2QX, United Kingdom

(51) INT CL⁶
H01J 23/18 23/36

(52) UK CL (Edition L)
H1D DK D16CY D16C1BX D16C1BY D16C1B1
D16C1Y D16M1 D16S7 D16S8 D16T1 D16T6
D18AY D18A1AY D18A1A1 D18A1BY D18A1B2B
D18A1B2Y D18A1X D18A1Y D18A3B D18A3Y D46C
D46Y

(56) Documents cited
GB 2238424 A GB 2017399 A GB 1100424 A
GB 1009870 A GB 0982806 A GB 0834628 A

(58) Field of search
UK CL (Edition K) H1D DK
INT CL⁶ H01J

(54) Magnetron

(57) A magnetron comprising a cathode 2 and an anode having a plurality of circumferentially spaced resonant cavities between vanes 3, has an output arrangement including a generally cylindrical resonant cavity 6 disposed co-axially at one end of the plurality of resonant cavities and within an axial magnetic field, and, in the arrangement shown, energy is coupled directly from each adjacent pair of resonant cavities into the cylindrical cavity by a circular vane strap 7 extending into cavity 6 and energy is coupled by an electric field probe and coaxial line 10 from the cylindrical cavity out of the magnetron. The use of a cylindrical resonant cavity ensures that energy can be coupled symmetrically from each adjacent pair of cavities. Similar resonant cavities 6, 6a, Fig 4 (not shown), may be provided at opposite ends of the anode vanes.

Alternatively, Figs 2 and 3 (not shown), energy is coupled to the cavity 6 by posts (20) extending between alternate vanes 3 and the roof (21) of the cavity, and a laterally extending loop output line (22), with a slidable short circuit (23), magnetically couples energy from the cavity 6.

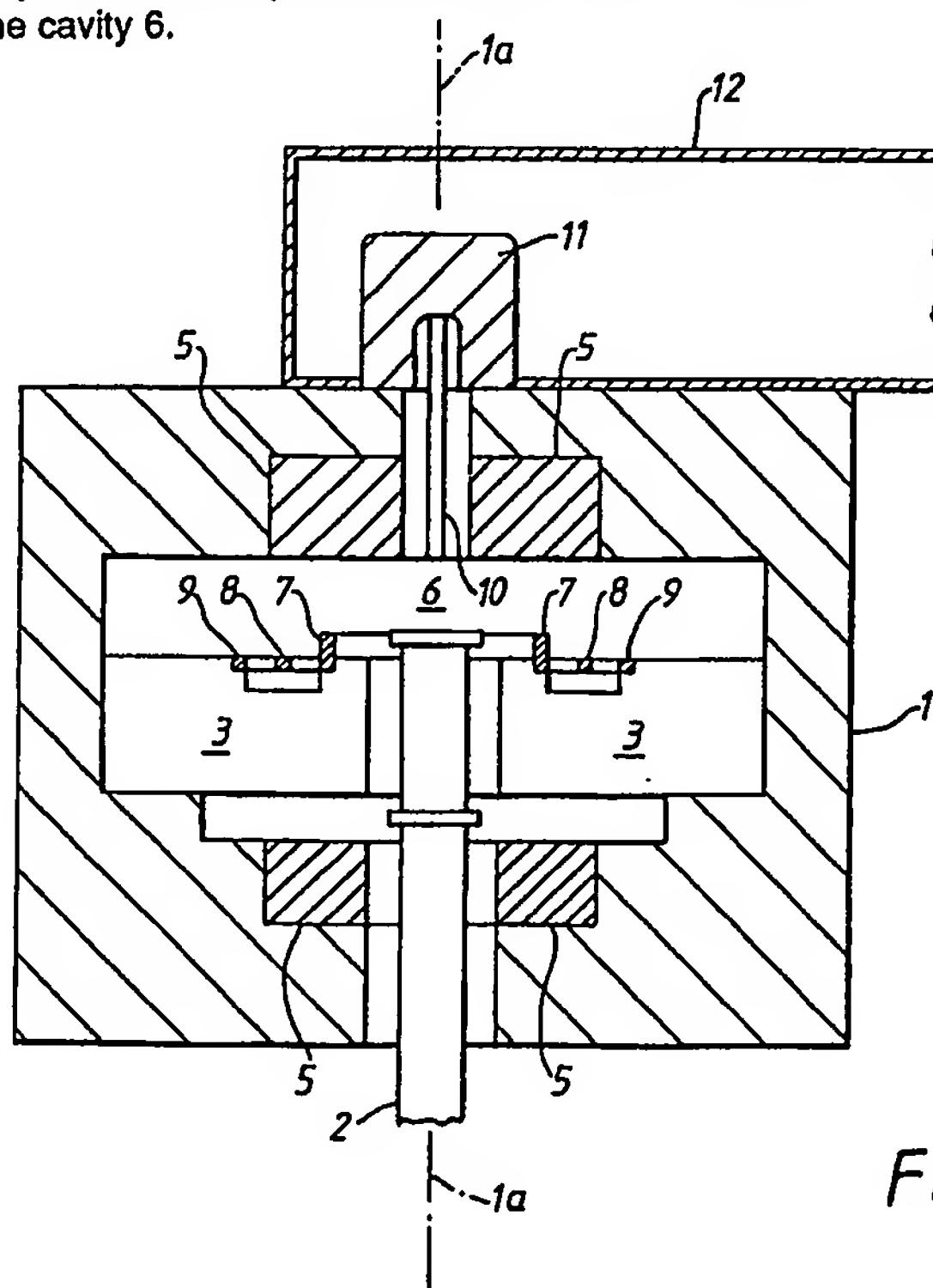


Fig. 1

GB 2 266 180 A

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

1/3

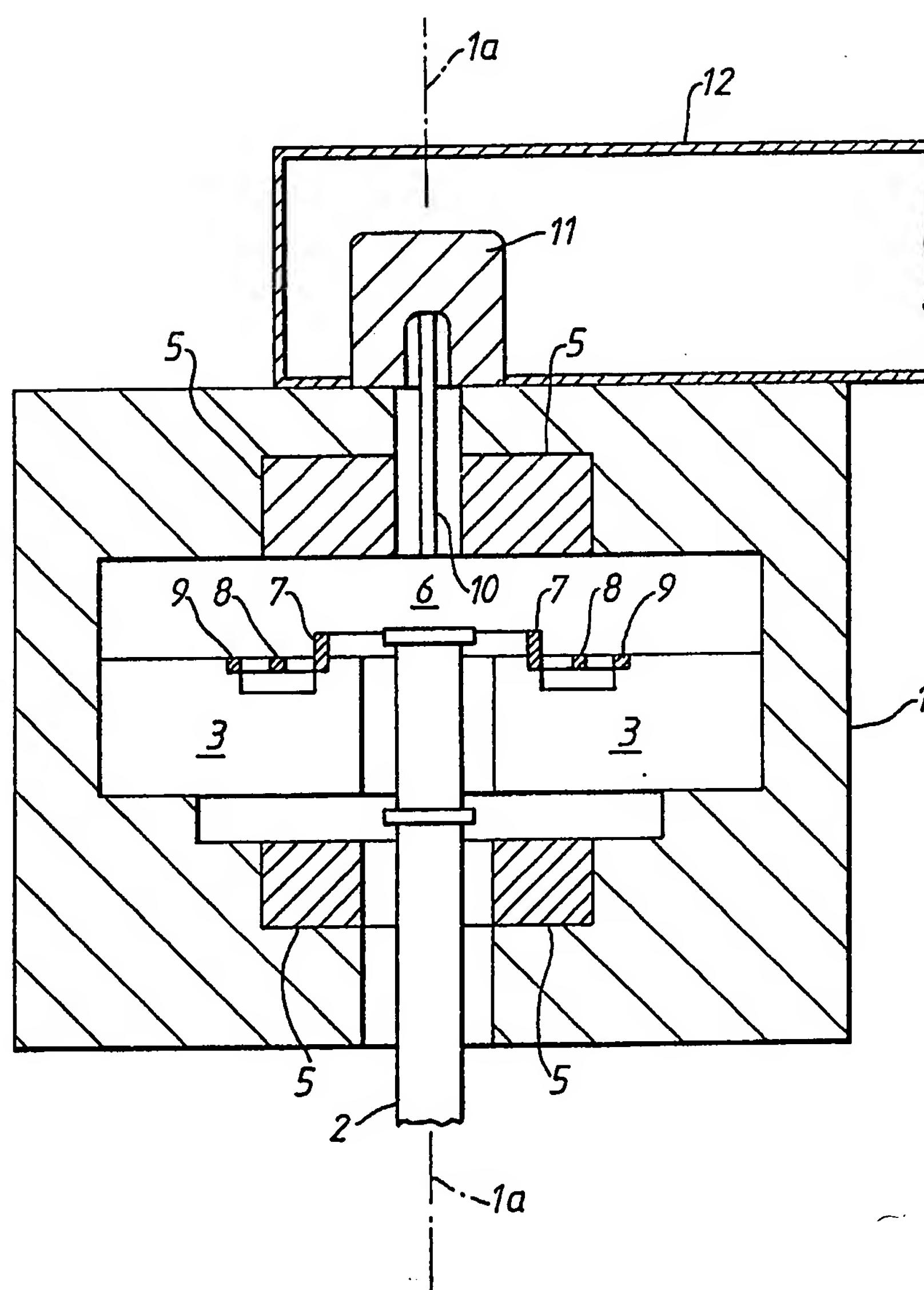


Fig. 1

2/3

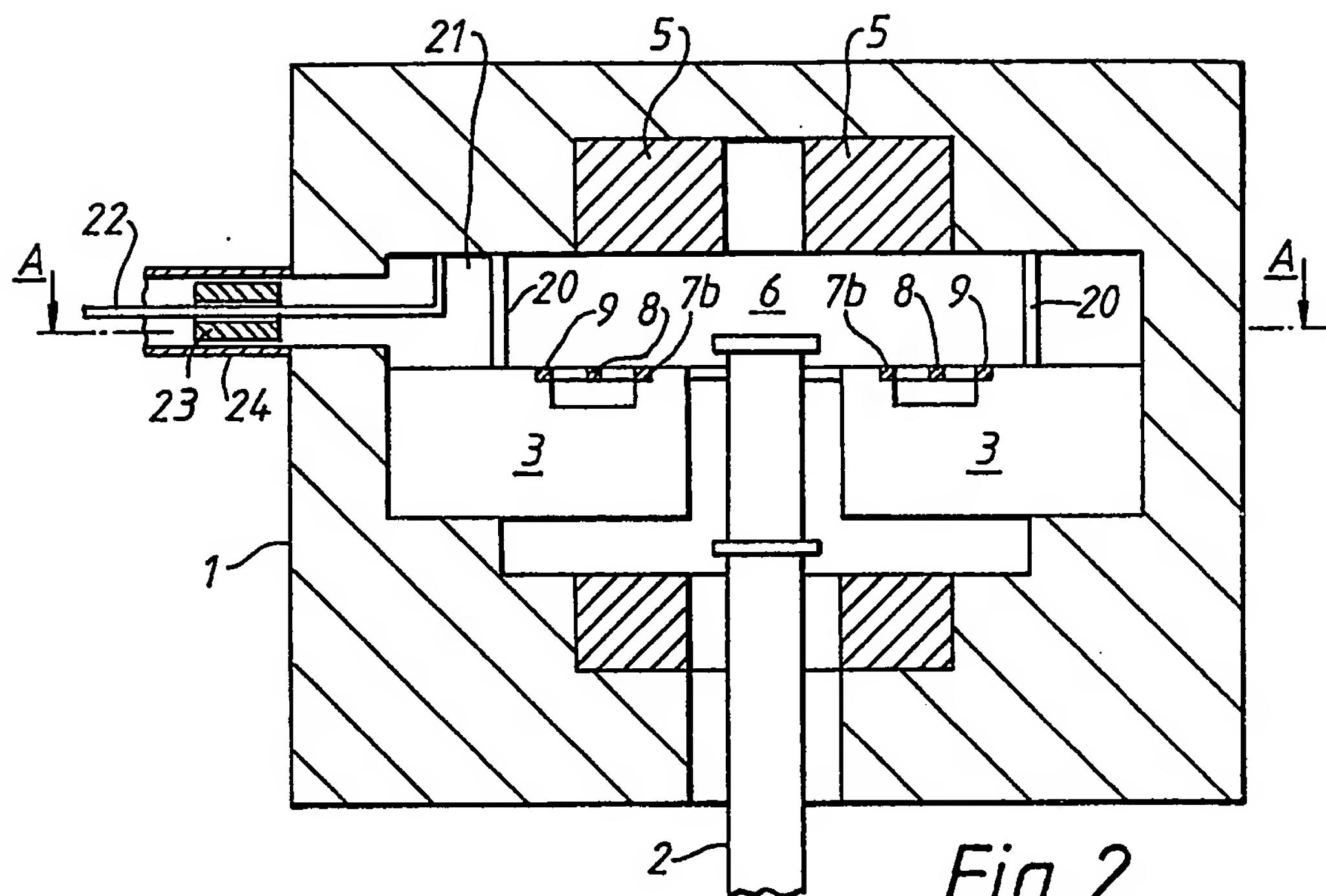


Fig. 2

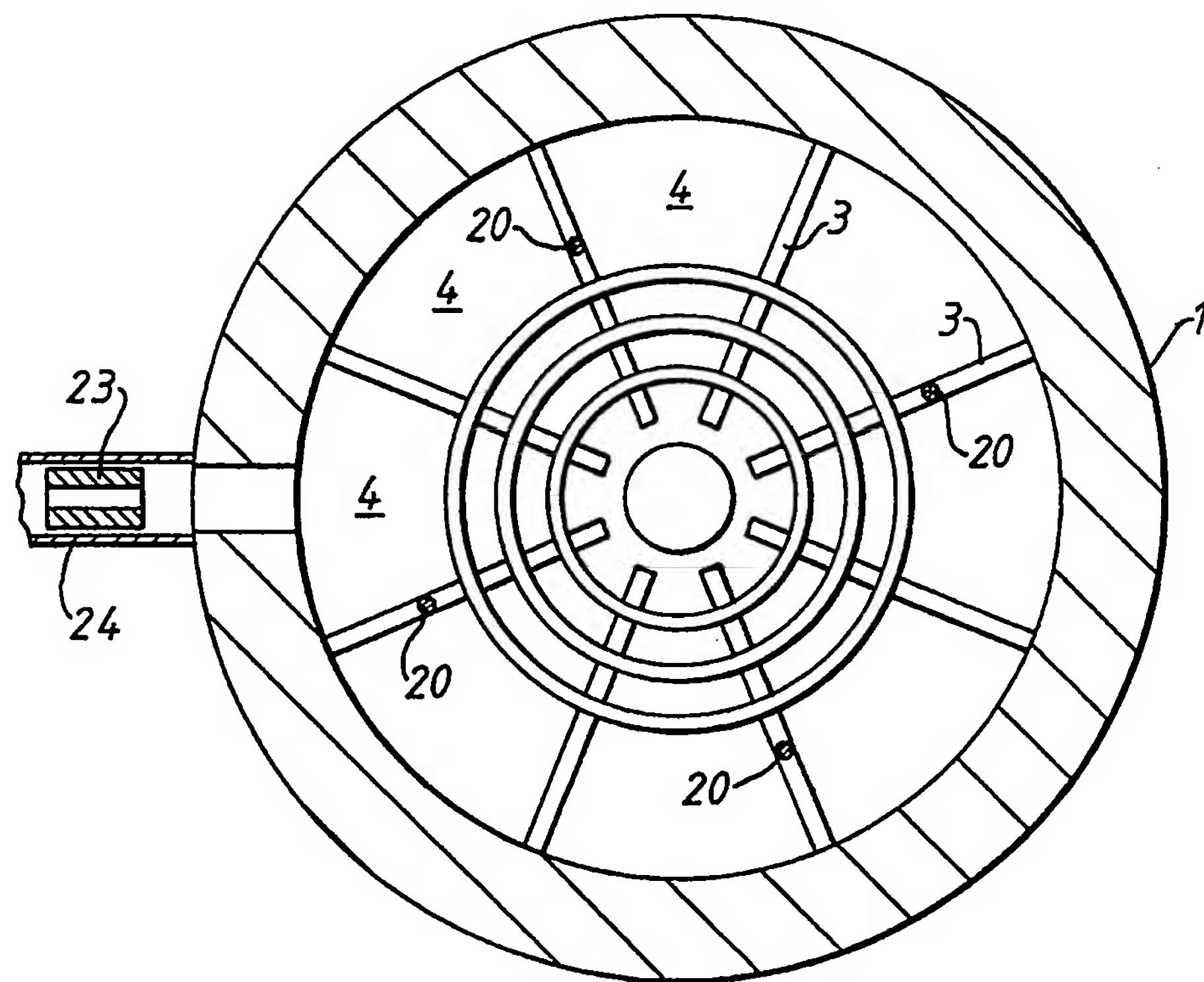


Fig. 3

3/3

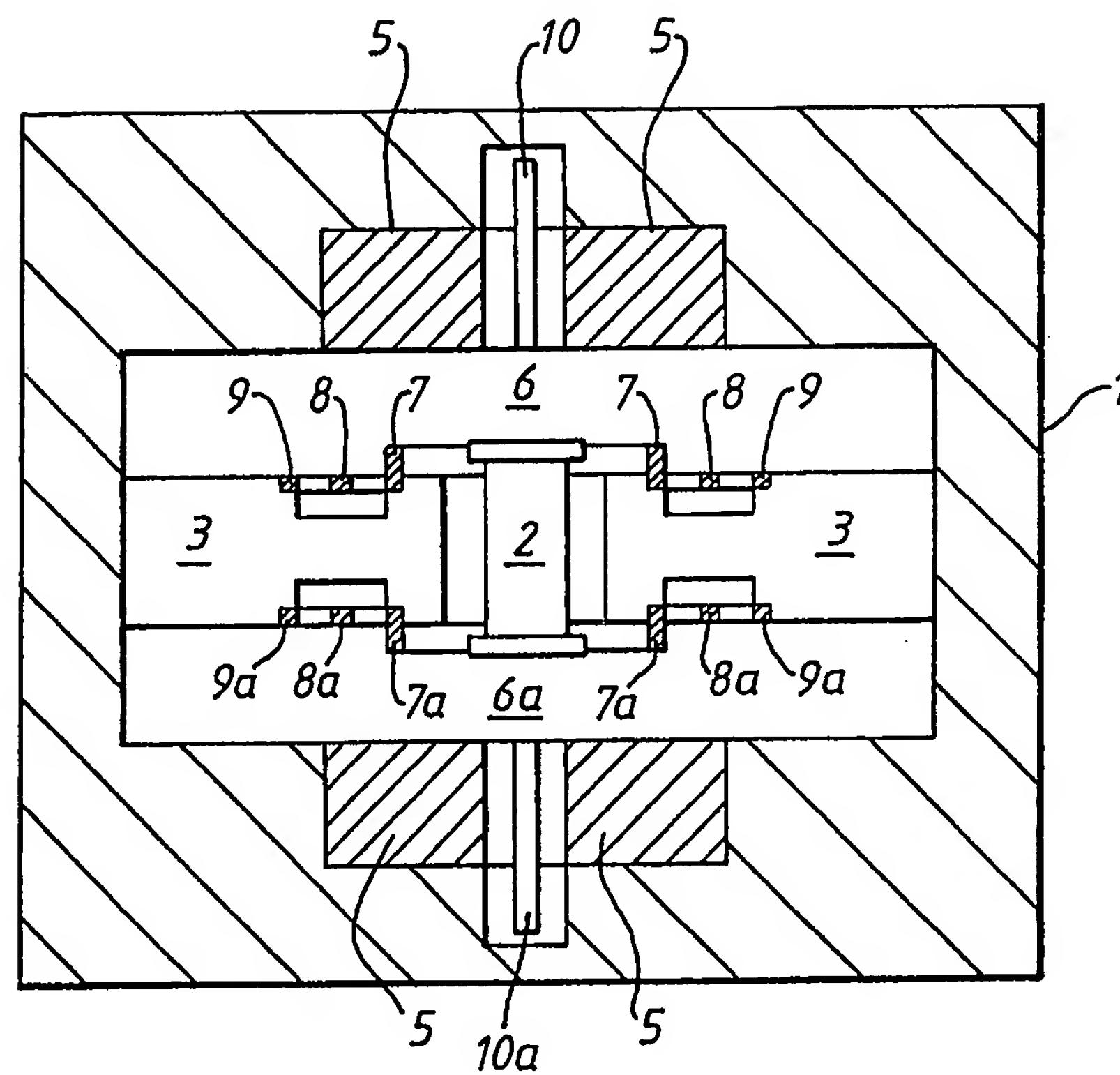


Fig. 4

- 1 -

MAGNETRON

The invention relates to a magnetron, and in particular to a magnetron having an improved output arrangement.

Conventionally, the output from a magnetron is taken by means of a probe attached to one of the walls separating adjacent resonant cavities in the anode. This can distort the R.F. field pattern and so cause a degradation in performance of the device. It is difficult to couple heavily into the anode structure, because of weak R.F. coupling between adjacent cavities, with the result that, with known magnetrons, much of the potentially available microwave energy cannot be emitted.

This invention provides a magnetron comprising a cathode, an anode having a plurality of resonant cavities circumferentially spaced about an axis, means for producing an axial magnetic field; and an output arrangement comprising a generally cylindrical resonant cavity disposed co-axially at one end of the plurality of resonant cavities within the magnetic field, means for coupling energy from the plurality of resonant cavities into the cylindrical

- 2 -

cavity, and means for coupling microwave energy from the cylindrical cavity out of the magnetron.

Because of the cylindrical cavity, energy can be coupled symmetrically from each adjacent pair of resonant cavities, without the distortions induced when energy is taken from one pair of cavities only.

The resonant frequency of the cylindrical cavity is preferably selected to be substantially the desired output frequency of the magnetron. In this way, the cavity will tend to suppress the emission of harmonics of the desired signal.

In one embodiment, the means for coupling energy from the plurality of resonant cavities comprises one of a plurality of circular straps connected to circumferentially alternate walls of the anode separating adjacent resonant cavities, which one strap projects axially into the cylindrical cavity further than another of the plurality of the straps.

An axially extensive electrostatic field is generated by the axially projecting strap from which energy is coupled into the cylindrical cavity from each adjacent cavity pair.

- 3 -

In an alternative embodiment posts extend axially across the cylindrical cavity from circumferentially alternate walls separating adjacent resonant cavities. In such a case electric current would travel around adjacent posts to generate a magnetic field by which energy can be coupled into the cylindrical cavity.

The output from the cylindrical cavity may comprise a conventional loop or an elongate probe which couples energy into a coaxial line.

In another embodiment the output may include a movable short circuit for tuning the resonant frequency of the cylindrical cavity.

In a yet further embodiment cylindrical resonant cavities may be disposed about each end of the plurality of circumferentially spaced cavities, which may be of use under especially high load conditions. In such a case, axially projecting straps may be present on each end of the walls of the anode. Output loops or probes may be located within each cylindrical cavity and connected to a common co-axial or other line.

- 4 -

In order that the invention may be well understood, various embodiments thereof will be described with reference to the accompanying diagrammatic drawings, in which;

Figure 1 is a partly schematic, partly longitudinal sectional view through a magnetron according to one embodiment of the invention;

Figure 2 is the same view as Figure 1, but shows a modification of that embodiment;

Figure 3 is a view across arrow A-A of Figure 2; and

Figure 4 is the same view as Figures 1 and 2 but showing a yet further embodiment of the invention.

As seen in Figure 1, a magnetron comprises a substantially cylindrical anode 1 having an axis 1a within which is located a co-axially mounted cathode 2. Vanes 3 extend inwardly from the inner walls of the anode 2 to define a plurality of circumferentially spaced resonant cavities 4 (see Figure 3). Magnetic pole pieces 5 provide an axially extending magnetic field at right angles to the electric field produced between the cathode 2 and anode vanes 3.

- 5 -

A generally cylindrical resonant cavity 6 is disposed co-axially at one end of the plurality of resonant cavities 4 in between the magnetic pole pieces 5. The resonant frequency of the cavity 6 is selected to be substantially equal to the desired output frequency of the magnetron and in this way tends to suppress the emission of harmonics of the main signal. As is well known, the resonant frequency of such a cylindrical resonator, in the E_{01} mode, is proportional to the radius of that cavity.

Circular straps 7, 8, 9 are connected to the anode vanes 3 in generally known manner. The radially innermost and outermost straps 7, 9 respectively are each connected to the same circumferentially alternate vanes 3 as each other, while the middle strap 8 is connected to the intervening vanes 3. The innermost strap 7 projects axially further into the resonant cavity 6 than the other straps and in this way is able, in use, to generate an electrostatic field by which energy can be electrically coupled into the cylindrical cavity 6 from each pair of adjacent resonant cavities 4.

An electric field probe and co-axial line 10 projects co-axially into the cylindrical cavity 6 in between the

- 6 -

uppermost, as shown, pole pieces 5. The end of the line 10 remote from the magnetron feeds a co-axial to waveguide transition member 11 for coupling energy into a waveguide 12.

The embodiment shown in Figures 2 and 3 is generally similar to that shown in Figure 1 and the same parts have been identified by the same reference numerals. Instead of electrically coupling into the cylindrical cavity 6, the innermost strap 7b is the same height as the other straps 8 and 9. Posts 20 extend between circumferentially alternate vanes 3 and the roof 21 of the cavity 6. In use, electric currents travel around the posts 6 and generate a magnetic field by which energy can be coupled into the cavity 6. Instead of the electric field probe, a loop output line 22 extends from one side for magnetically coupling energy from the cavity 6. A slid able short circuit 23 is located within a waveguide 24 for adjusting or tuning the resonant frequency of the cavity 6 so that the output frequency of the magnetron may be pulled over a short range.

In the embodiment shown in Figure 4, as compared to the Figure 1 embodiment, an extra cylindrical resonant cavity 6a is disposed co-axially at the other end, the bottom as shown, of the plurality of resonant cavities 4. A

- 7 -

further arrangement of straps 7a, 8a, 9a, a mirror image of straps 7, 8, 9, is provided on the lower end of the plurality of vanes 3. A further co-axial electric field probe 10a projects into the resonant cavity 6a and, although not shown in this view, each probe 10, 10a is connected to a common co-axial line for emission, e.g. into an appropriate waveguide. Such an arrangement is particularly suitable if especially heavy coupling is required with the anode.

Each of the magnetrons shown has the advantage that microwave energy can be coupled into the cylindrical resonant cavity symmetrically from each pair of adjacent resonant cavities 4, which ensures low distortion in the output signal and ensures the efficient transfer of energy. The cylindrical resonant cavity can also be selected to suppress harmonics of the output signal. Normally, in the known magnetrons, resonances in the space above and/or below the vanes can be a problem requiring careful design or the use of extra filters.

Variations may be made to the embodiments shown. For example the anode structure may include integrally formed separating walls which separate the circumferential resonant cavities. The three straps shown coupling together the anode vanes may be replaced by a pair of straps. Magnetic

- 8 -

loop outputs may be used as an alternative to the electric field probes shown in the Figures 1 and 4 embodiments. Similarly, in the Figure 4 embodiment one or both cavities 6, 6a may include a tuning arrangement for varying the resonant frequency and energy need not be coupled out from each of the cavities.



- 9 -

CLAIMS

1. A magnetron comprising a cathode, an anode having a plurality of resonant cavities circumferentially spaced about an axis, means for producing an axial magnetic field; and an output arrangement comprising a generally cylindrical resonant cavity disposed co-axially at one end of the plurality of resonant cavities within the magnetic field, means for coupling energy from the plurality of resonant cavities into the cylindrical cavity, and means for coupling energy from the cylindrical cavity out of the magnetron.
2. A magnetron, as claimed in claim 1, in which cylindrical resonant cavities are disposed at each end of the plurality of circumferentially spaced cavities.
3. A magnetron, as claimed in claim 1 or 2, in which the resonant frequency of the or a cylindrical cavity is selected to be substantially the desired output frequency of the magnetron.
4. A magnetron, as claimed in claim 1, in which the means for coupling energy from the plurality of resonant cavities, comprises one of a plurality of circular straps connected to circumferentially alternate walls of the anode

- 10 -

separating adjacent resonant cavities, which one strap projects axially into the or a cylindrical cavity further than another of the plurality of straps.

5. A magnetron, as claimed in claim 1, 2 or 3, in which posts extend axially across the or a cylindrical cavity from circumferentially alternate walls separating adjacent resonant cavities.

6. A magnetron, as claimed in any preceding claim, in which the output from the or a cylindrical cavity comprises a loop.

7. A magnetron, as claimed in any of claims 1 to 5, in which the output from the or a cylindrical cavity comprises an electric field probe.

8. A magnetron, as claimed in any preceding claim, in which the output from the or a cylindrical cavity includes a movable short circuit for tuning the resonant frequency of the cylindrical cavity.

9. A magnetron, substantially as described with reference to any one of the accompanying drawings.

Relevant Technical fields	Search Examiner
(i) UK CI (Edition K) H1D-DK	R H LITTLEMORE
(ii) Int CI (Edition 5) H01J	
Databases (see over)	Date of Search
(i) UK Patent Office	27 JULY 1992
(ii)	

Documents considered relevant following a search in respect of claims

1-9

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	GB 2238424 A (EEV) - see cavity between 9 and 10, Figure 2 coupled by structures anode segment cavities	1,7
X	GB 2017399 A (HITACHI) - eg see Figures 2 and 5	1,3,6
X	GB 1100424 (KOBE KOGYO) - see Figure 1	1
X	GB 1009870 (GENERAL ELECTRIC) - see Figure 1, rods 60 connect vanes to output circuit	1,5,7
X	GB 982806 (AEI LTD) - members 19, 21 connect straps 13, 15 to output circuit	1,4,7
X	GB 834628 (ENGLISH ELECTRIC VALVE) Figure 2, ring or disc 10 connects anode segments to output waveguide	1



Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family, corresponding document.

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).